For Supervisor's use only

2

90254

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2003

90254 Demonstrate understanding of wave phenomena

Credits: Four
2.00 pm Thursday 20 November 2003

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

For all 'describe' or 'explain' questions, the answers should be written or drawn clearly with all logic fully explained.

For all numerical answers, full working must be shown and the answer must be rounded to the correct number of significant figures and given with an SI unit.

Formulae that you may find useful are given on page 2.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–14 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only

Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships. ☐	Give concise explanations, that show clear understanding, in terms of phenomena, concepts, principles and/or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
Overall Level of Performance (all criteria within a column are met) ☐		

You may find the following formulae useful.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \text{or} \quad s_i s_o = f^2$$

$$m = \frac{d_i}{d_o} = \frac{h_i}{h_o} \quad \text{or} \quad m = \frac{f}{s_o} = \frac{s_i}{f}$$

$$n_i \sin\theta_1 = n_2 \sin\theta_2 \qquad \frac{n_1}{n_2} = \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$$

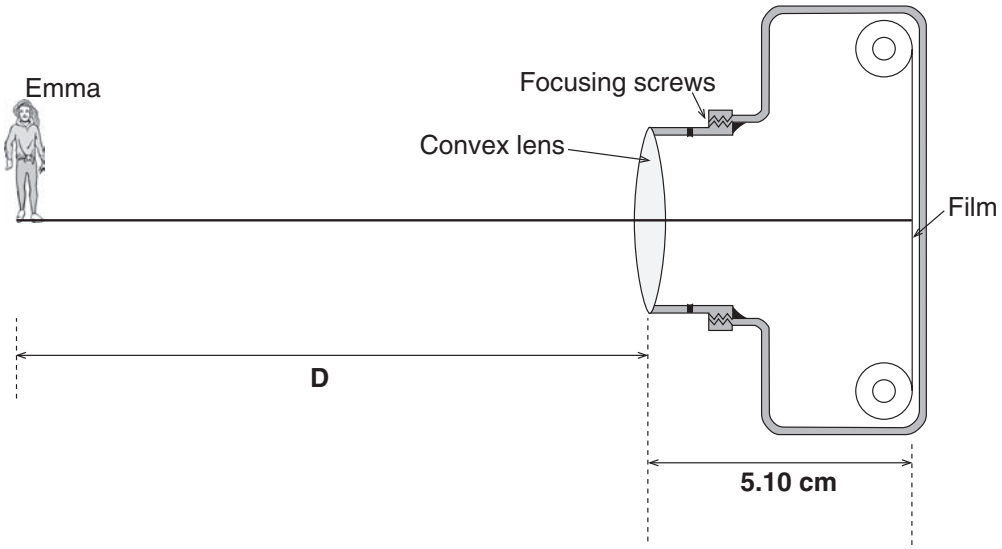
$$v = f\lambda \qquad f = \frac{1}{T}$$

You are advised to spend 40 minutes answering the questions in this booklet.

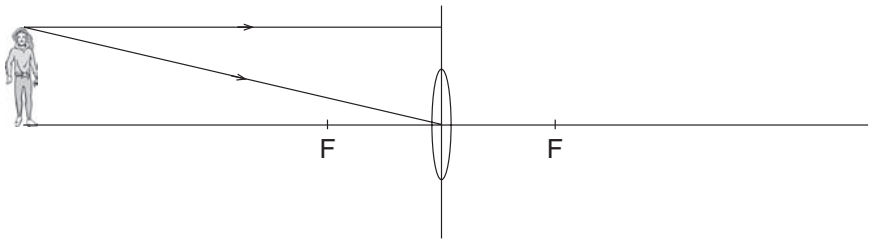
Assessor's use only

QUESTION ONE: The Camera

Moana is taking photos of her friend, Emma, using an ordinary film camera. A very simple form of a film camera consists of a light-tight box with a convex (converging) lens at one end and the film at the other end.



(a) Complete the ray diagram below (**not drawn to scale**) to show how the image of Emma is formed on the film. Draw an arrow to represent the image.



(b) Describe the nature of the image formed on the film.

Emma stands at a distance **D** cm in front of the camera lens. A sharp image of Emma is formed on the film. In this position, the distance of the lens from the film is **5.10 cm**. The lens has a focal length of **5.00 cm**.

(c) Show that the distance from Emma to the camera lens, **D**, is **255 cm**.

(d) Calculate the magnification of the image.

Magnification = _____

(e) The image of Emma on the film is **3.20 cm** high. Calculate Emma's actual height.

Height = _____

The girls are now playing with Jackson the cat. Emma takes a 'close-up' photo of the cat. A sharp image of the cat is formed on the film when its distance from the camera lens is 10 times greater than the distance of the lens to the film. The focal length of the lens is **5.00 cm**.

(f) Calculate the distance of the cat from the camera lens.
(You may use **either** a formula **or** a scale diagram, but not both.)

If you are using a formula to calculate the distance, use the lines below.

Distance = _____

If you are using a scale diagram to calculate the distance, use the grid below.

Assessor's use only

Vertical axis: 1 square represents 1 cm **Horizontal axis**: 1 square represents 10 cm

Distance = _____

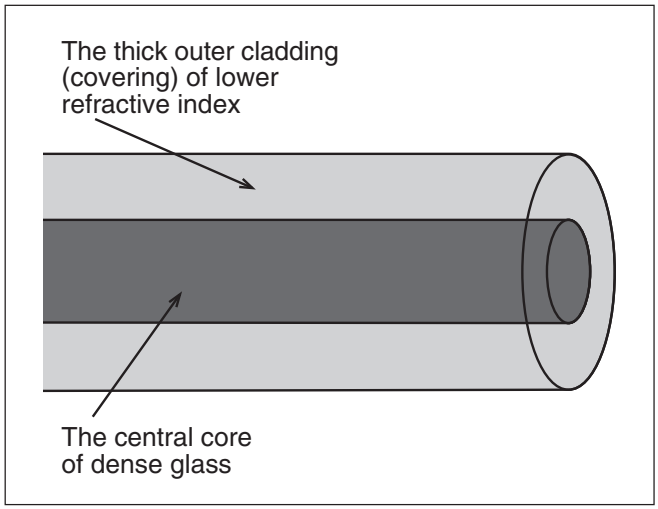
If you need to redraw this diagram, use page 13.

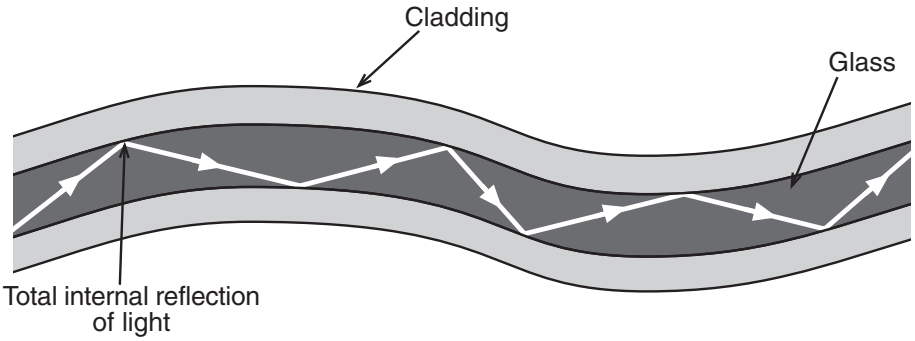
QUESTION TWO: Light and Sound

Assessor's use only

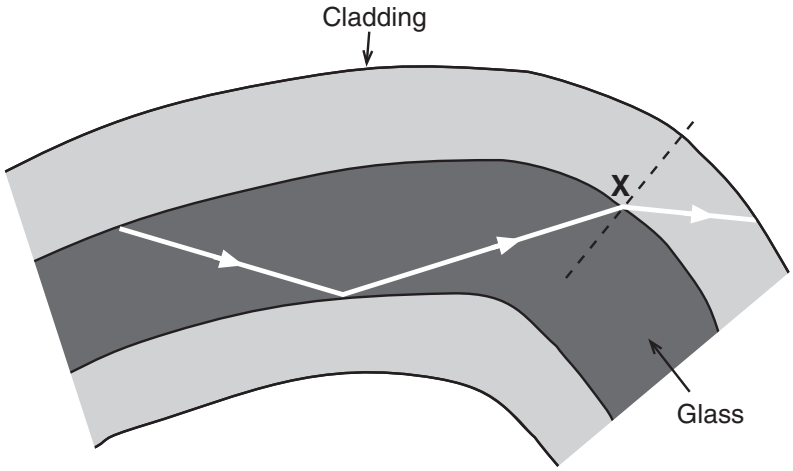
Part A: Refraction of light in optical fibres

An optical fibre is a **flexible, solid tube** that carries light from one place to another. As thin as a human hair, it has a **central core** made up of glass. This core has a **cladding** (covering) of lower refractive index. Because the cladding has a lower refractive index than the core, the light rays inside the core are **totally internally reflected**. If the optical fibre is kept mainly straight, the light can travel great distances without losing much energy.





When the fibre is bent too much, the light can be refracted. It would then escape from the glass as shown at the point **X** in the diagram below.



(a) On the diagram above, label the angle of refraction of the light at point **X**, using the letter **R**.

Use the information in the box below to answer (b) and (c).

Refractive index of cladding	= 1.51
Angle of incidence in glass	= 45.2°
Angle of refraction in cladding	= 52.7°
Speed of light in cladding	= 1.971×10^8 m s^{-1}

Assessor's use only

(b) Show that the refractive index of the glass is **1.69**.

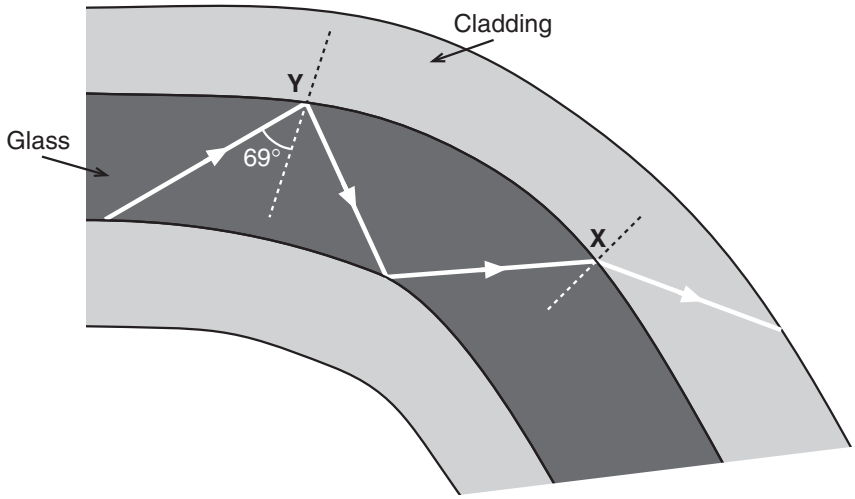
(c) Calculate the speed of light in the glass.
Write down your answer to the correct number of significant figures.

Speed = _____

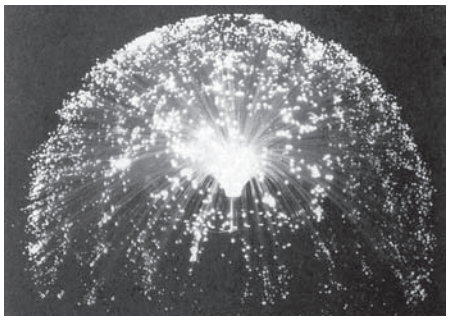
(d) For total internal reflection to take place, the light inside the glass must reach the critical angle of the glass/cladding boundary.

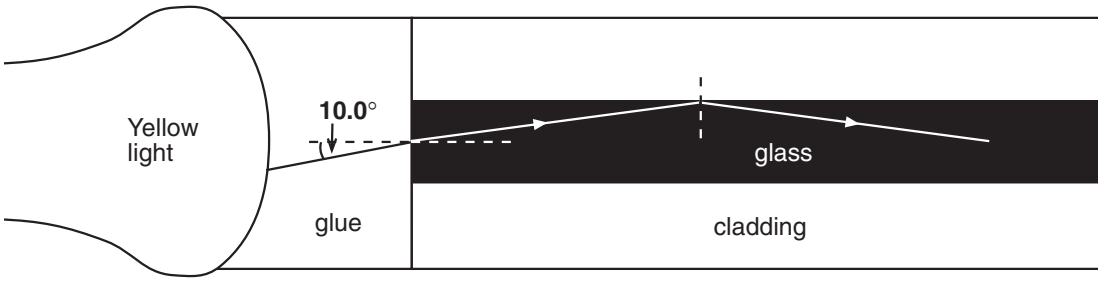
(i) Explain what is meant by the phrase **the critical angle of the glass/cladding boundary**.

(ii) Use the information in (d)(i) to explain why light is reflected at point **Y** in the diagram below. The critical angle of the glass/cladding boundary is **64**°.



A decorative optical fibre light is made by gluing optical fibres to a yellow light. The refractive index of the glue is **1.36** and the refractive index of the core glass is **1.58**. A ray is incident on the end of the fibre at **10.0**°, as shown in the diagram below.



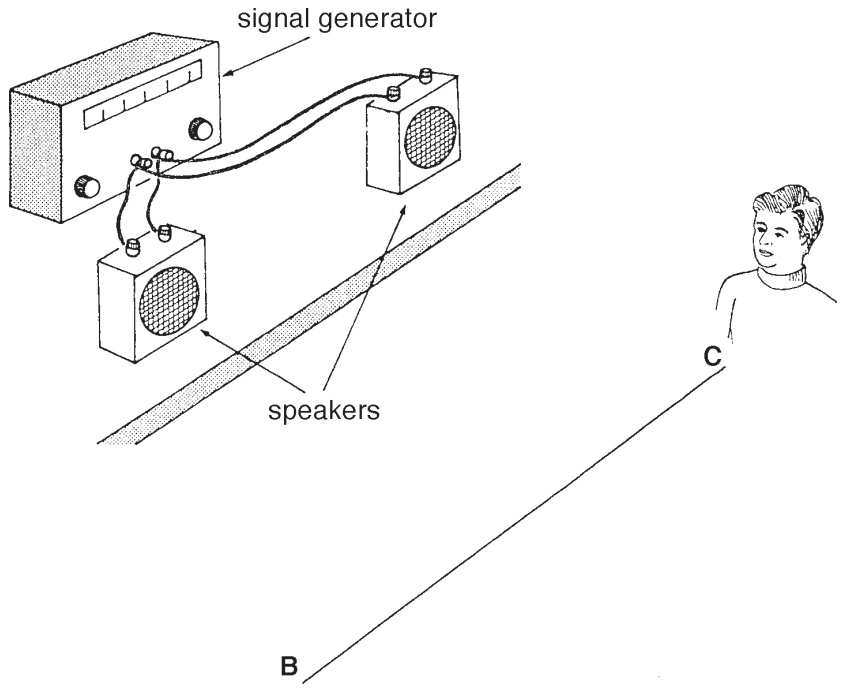


(e) Calculate the **angle of reflection** at the glass/cladding boundary.

Part B: Interference of sound

Assessor's use only

In a physics investigation to study sound, Tom places two identical speakers some distance apart. He then connects them to a signal generator to send out sound waves of a certain frequency, as shown in the diagram below. An interference pattern is produced.

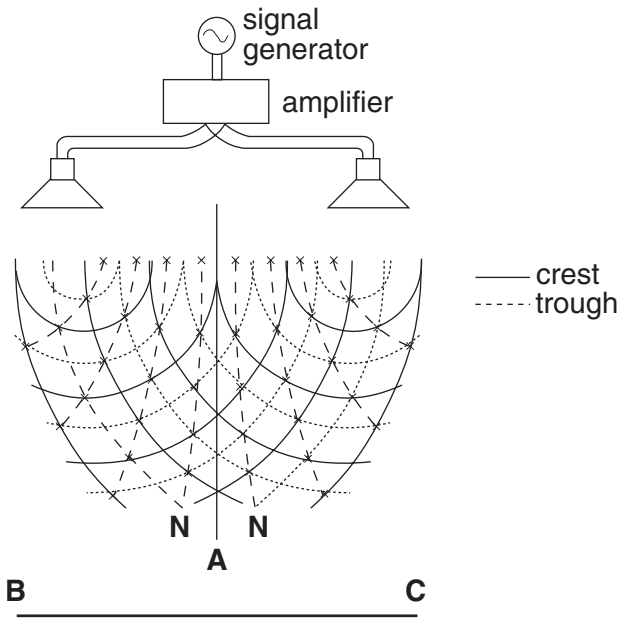


The speed of sound in air is **340 m s^{-1}** and the wavelength of the sound waves produced by the speakers is **0.48 m**.

(a) Calculate the frequency of the sound waves produced by the speakers.
Give the correct SI unit with your answer.

Frequency = _____

The interference pattern has a series of nodal lines (labelled **N**) and antinodal lines (labelled **A**), as shown in the diagram below.



(b) Tom would hear very little sound at any point along a nodal line.

Explain how this nodal line is produced.

(c) Describe what Tom would expect to hear if he walked in front of the speakers along the line **BC**.

(d) The frequency of sound produced by the speakers is now reduced to half of its original value and Tom hears a note of lower pitch. The distance between two nodal lines is directly proportional to the wavelength of the sound.

Describe and explain ONE **other** change that he would hear when he walks along the line **BC**.

Description:

Explanation:

QUESTION THREE: Water Waves

Assessor's use only

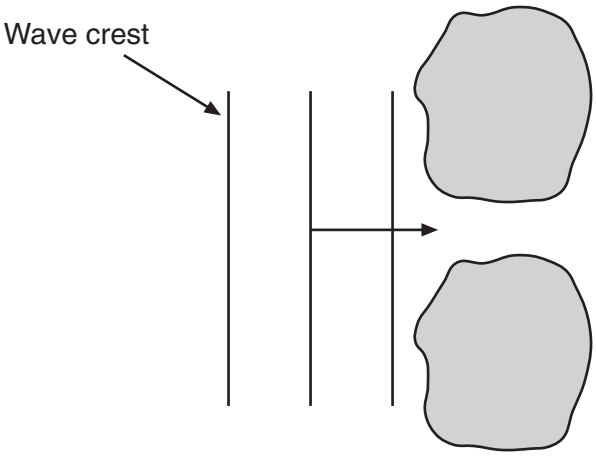
The waves coming into the narrow mouth of the Hokianga Harbour seem to bend around the headlands as they come into shore.

(a) What is the name given to this bending of waves around an object?

_____

At another place in the harbour, the waves arrive at two large rocks, as shown in the diagram below.

(b) Draw the wave pattern that is made after the waves pass through the gap between these two rocks.
Indicate the direction of the waves by using an arrow.



(c) Explain the condition that is necessary for this wave pattern to be formed.

_____

_____

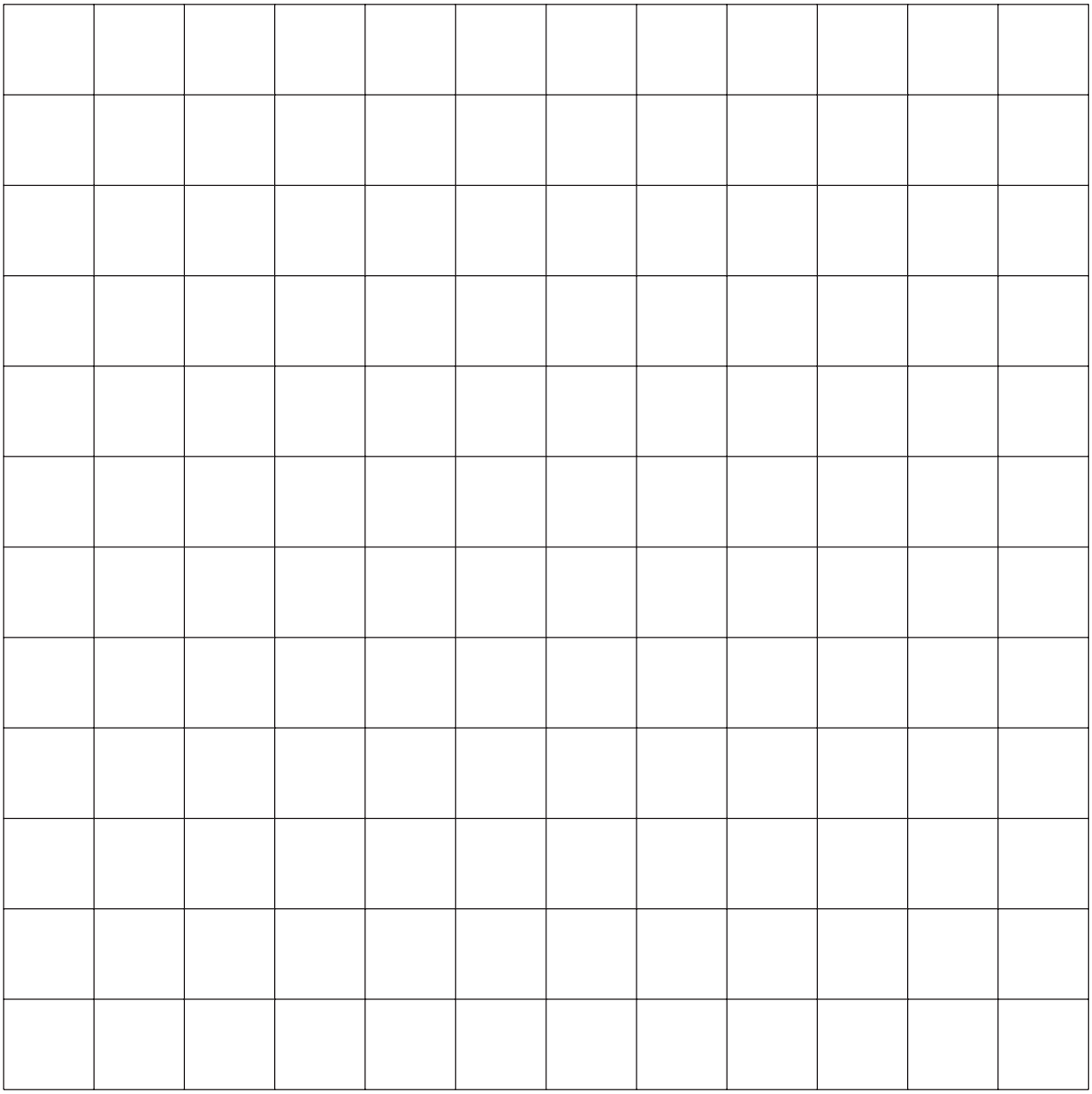
(d) Kathryn was on the beach studying the waves. She recorded **6.0** complete waves reaching the shore in **29.7 s**. She estimated the distance between five crests to be **16 m**.

Calculate the speed of the waves as they reached the beach.

Assessor's use only

If you have made a mistake and need to redraw the diagram, use the copy printed here.

Assessor's use only



Extra paper for continuation of answers if required.
Clearly number the question.

Assessor's use only

Question Number